

"Express Mail" mailing label number EE21251626005

U.S. APPLICATION NO. (if known, see 37 CFR 1.4)		INTERNATIONAL APPLICATION NO.		ATTORNEY'S DOCKET NUMBER	
10/070723		PCT/EP00/08710		PS-13393	

<p>17. <input checked="" type="checkbox"/> The following fees are submitted:</p> <p><b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b></p> <p>Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1000.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO. .... \$ 860.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$ 710.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$ 690.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$ 100.00</p> <p style="text-align: right;"><b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b></p> <p>Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(c)).</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="width:15%;">CLAIMS</th> <th style="width:20%;">NUMBER FILED</th> <th style="width:20%;">NUMBER EXTRA</th> <th style="width:20%;">RATE</th> <th style="width:15%;"></th> <th style="width:10%;"></th> </tr> <tr> <td>Total claims</td> <td>18 - 20 =</td> <td>0</td> <td>X \$ 18.00</td> <td>\$</td> <td>0 00</td> </tr> <tr> <td>Independent claims</td> <td>1 - 3 =</td> <td>0</td> <td>X \$ 80.00</td> <td>\$</td> <td>0 00</td> </tr> <tr> <td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable)</td> <td>+\$260.00</td> <td>\$</td> </tr> <tr> <td colspan="4" style="text-align: right;"><b>TOTAL OF ABOVE CALCULATIONS =</b></td> <td>\$</td> <td>890 00</td> </tr> <tr> <td colspan="4">Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4" style="text-align: right;"><b>SUBTOTAL =</b></td> <td>\$</td> <td>890 00</td> </tr> <tr> <td colspan="4">Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4" style="text-align: right;"><b>TOTAL NATIONAL FEE =</b></td> <td>\$</td> <td>890 00</td> </tr> <tr> <td colspan="4">Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property</td> <td>+</td> <td>\$</td> </tr> <tr> <td colspan="4" style="text-align: right;"><b>TOTAL FEES ENCLOSED =</b></td> <td>\$</td> <td>890 00</td> </tr> <tr> <td colspan="4"></td> <td>Amount to be refunded:</td> <td>\$</td> </tr> <tr> <td colspan="4"></td> <td>charged:</td> <td>\$</td> </tr> </table>	CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE			Total claims	18 - 20 =	0	X \$ 18.00	\$	0 00	Independent claims	1 - 3 =	0	X \$ 80.00	\$	0 00	MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+\$260.00	\$	<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$	890 00	Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$		<b>SUBTOTAL =</b>				\$	890 00	Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$		<b>TOTAL NATIONAL FEE =</b>				\$	890 00	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				+	\$	<b>TOTAL FEES ENCLOSED =</b>				\$	890 00					Amount to be refunded:	\$					charged:	\$	<p><b>CALCULATIONS PTO USE ONLY</b></p>
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a. ☒ A check in the amount of \$ 890.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.

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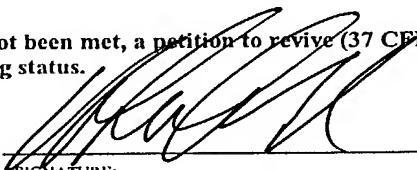
**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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10070723 10/070723

JC10 Rec'd PCT/PTO 06 MAR 2002

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Patent for method, device and installation for the treatment of  
fluids on at least one bulk material layer

The invention relates to a method for treating, in particular cleaning, fluids according to the preambles of Claims 1 and 18, as well as a charging device and a gas treatment installation to carry out the method according to the preambles of Claims 8 and 10.

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In installations for treating large quantities of gas, produced, for example, as waste gas in combustion processes, in particular for removing environmentally polluting compounds, such as dioxins, furans, sulfur compounds, chlorine compounds, nitrogen compounds, hydrocarbons, heavy metals and/or other components, on a bulk material, one substantial problem consists of the large surface area of the bulk material layer, which is occasionally also referred to as "filter." Indeed, it is desirable to keep the resistance to flow through the bulk material layer small, while at the same time ensuring a consistent high treatment quality throughout the entire filter cross section. To achieve this, the bulk material, if it is to be used in countercurrent with respect to the fluid to be treated, which is a particularly effective method, must be repeatedly and evenly removed at the floor of the bulk material layer, the feed inlet floor, while fresh

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bulk material is delivered evenly distributed over the surface of the bed, in a bulk material portion exchange. This problem has been solved on a large industrial scale by means of so-called moving bed reactors, as described in the Patents WO 88/08746, WO 91/12069 and EP 0 472 565.

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With these known methods, devices and installations, the bulk material is supplied through bulk material reservoir bin and bulk material distribution floors, which are arranged immediately above each bulk material bed. The bulk material unloading openings of the bulk material distribution floors consist of permanently open pipe mouths, where a cone of bulk material forms under each mouth. Since these mouth openings are evenly distributed over the bed cross section, the bulk material bed surface consists of a multitude of such bulk material cones. The space which necessarily remains between the bulk material bed surface and the bulk material distribution floor of each bed acts as a gas collecting space, which space is connected via a closable opening in the lateral wall of the container (reactor) which receives the bulk material bed with a gas collection or exhaust channel, into which the combined waste gas streams of all the beds flow. As a result of the permanently open mouth or discharge openings of the bulk material distribution floor, the fluid to be treated can also penetrate into the bulk material reservoir bin. Therefore, special steps must be taken so that the refill openings of the bulk material reservoir bin are always closed with sufficient seal and that any treated gases which penetrate into the reservoir bin do not cause any undesired reactions in the reservoir bins, for example, as a result of oxygen containing creep flow, so-called hot spots.

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An additional problem consists in the fact that the suitability of the available treatment bulk materials is highly variable and, in the case of particularly high concentrations of fluid components to be treated and/or great differences between the fluid components to be treated - it is not sufficient to achieve the desired treatment result in a single processing step.

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An additional problem in the mentioned fluid treatment installations consists in the fact that the type of distribution of the bulk material on the reactor beds and/or the application of the bulk material results in a relatively rigid establishment of a predetermined process type in the fluid treatment sequence.

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As a result of the above, the invention is based on the problem of proposing a method, a bulk material delivery device and a gas treatment installation, by which a higher flexibility of the fluid treatment by means of a moving bed reactor filled with bulk material is achieved. Furthermore, it is desirable that the risk of leaks for treated gas above the bulk material bed be reduced.

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Since known moving bed reactor installations present a high installation height in comparison to the bed height, a special goal consists in clearly reducing the size of the installation and thus also the cost of the construction of such an installation.

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Since, in known moving bed reactor installations, the automatic or semi-automatic refilling from the reservoir bins occurs above the adjacent bulk material beds, for example, via chain bucket conveyors and reservoir bin port holes which can be opened and closed, an additional goal of the invention is to reduce the effort required for the distribution of bulk material on the individual bulk material beds. It is also desirable to reduce the wear due to abrasion which the bulk material undergoes in known bulk material distribution installations; i.e. in general it is desirable to use milder conditions for the fresh bulk material.

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Finally, another goal of the invention is to broaden the possibilities of fluid treatment a single treatment step, in particular to create a simplified possibility of treating the fluid on bulk materials with different treatment properties in case the same bulk material layer is used, for example, on the one hand, by adsorption, and, on the other hand, by chemical reaction, as is known for bulk material

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mixtures made, for example, of activated charcoal or activated coke, on the one hand, and calcium hydroxide, on the other hand, for example, in the entrained stream method, in which bulk materials are finely ground for the formation of an entrainment stream (together with the fluid to be treated).

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To solve the problem mentioned above, the method having the characteristics of Claim 1 or 18, the bulk material delivery device having the characteristics of Claim 8 and/or gas treatment installations having the characteristics of Claim 10 are proposed.

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Accordingly, the invention is based on the fundamental notion of using a bulk material delivery container inside or outside the reactor, which is loaded in a charging position with bulk material and which is moved over the different bulk material beds for the delivery of bulk material portions. In particular, this arrangement can be such that the bulk material delivery container is provided with at least one loading opening and at least one closable unloading opening, and, after loading with the bulk material, it is moved from the charging position over a first bed. There at least one unloading opening is cleared, and the unloading is continued until the bulk material bed located under it has again reached its desired height of bulk material, after, or at the same time as, the removal of a bulk material portion at the lower bed end. Then the unloading opening, of which there is at least one, is closed, and the bulk material delivery container is moved to another bed or into another loading position of the same bed. The process of bed refilling can then be repeated after the move to the next bulk material bed. Later, the bulk material delivery container returns to its charging position, for reloading with bulk material.

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Advantageously, a bulk material delivery container has a width which corresponds to the width of the bulk material bed perpendicularly with respect to the direction of movement of the bulk material delivery container. The length of the direction of movement of the bulk material delivery container can be as large

It is also possible to use several charging containers with linear charging opening, which containers are filled with different bulk materials, for example, one with an adsorption agent and another one with a chemical reactant. If the

charging containers are successively moved relative to the bulk material delivery container and another bulk material layer is respectively deposited in the bulk material delivery container, the bulk material delivery container is thus filled with approximately parallel, in particular planar parallel layers of different fluid treatment agents. The same effect can be achieved if the bulk material delivery container moves, as it is filled, under a partitioned reservoir bin with adjacent outlet openings. Then planar parallel layers of different granulates on top of each other can be achieved. The layer thickness is here determined by the vertical separation between the reservoir bin outlet openings. If, during the bulk material portion exchange, the added quantity of bulk material is appropriately controlled, then at least one thin layer of each one of the bulk materials is transferred into the corresponding bulk material bed. As a result it becomes possible to achieve bulk material beds with a layered structure, where different gas treatment processes simultaneously occur in the beds, for example, adsorption processes and chemical conversion processes. It is also possible to move several bulk material delivery containers filled with different fluid treatment agents successively over the bulk material beds to achieve the same layering effect. Another possibility is to fill the same bulk material delivery container successively with various fluid treatment agents and to empty them over the same bulk material beds. A bulk material layer can also be structured as a mixture of different granulates.

It is clear from the above that a "fluid treatment" in the sense of the invention can be, among other possibilities, a chemical treatment, an absorptive cleaning treatment, and also a heat treatment. Heat treatments can be carried out, for example, by the introduction of heat energy carriers or by the generation of heat by a chemical reaction.

A gas treatment installation according to the invention for carrying out the method described above presents a horizontal charging channel, which is arranged above the bulk material beds and connects them to each other, so that



the bulk material delivery container can be moved through the charging channel between a charging position and the bulk material delivery positions above the beds. Such a charging channel can be arranged above bulk material distribution floors, which in turn are arranged above each bulk material bed. The charging channel can be arranged outside of the reactor; it is preferred for it to be accommodated inside the reactor. It can replace the reservoir bins. The reservoir bins provided according to the state of the art for each bulk material bed can thus be combined above the bulk material distribution floors into a common horizontal charging channel. As a result, both the filling openings for the reservoir bins as well as the material abrading transport of the bulk material above the reactor cover, as known from the state of the art cited above, are omitted. In the same manner it is also possible to completely omit the bulk material distribution floors and to combine the gas collection spaces of adjacent bulk material beds into a horizontal charging channel. As a result, the construction height of the gas treatment installation is reduced even further. In such an arrangement, the bulk material delivery container can take over the function of throttle or closing flaps, which prevent the exit of treated gas out of a bulk material bed when the bulk material delivery container is located above the bulk material bed concerned and a bulk material portion refilling is carried out. This throttles or prevents the flow of the gas stream through the bulk material bed concerned, as desired in Patent WO 91/12069. Advantageously, in the present invention, the throttle or closing devices can be omitted, and their function is taken over by the bulk material delivery container.

The bulk material removal under each bulk material bed, as described in the state of the art mentioned above, can be carried out through funnels or, to achieve a lower construction height, by means of a conveyor belt. However, it is particularly advantageous if, below the bulk material delivery openings of the bulk material removal floors of the individual bulk material beds, a horizontal disposal channel is provided through which a longitudinal conveyor means for bulk material removal transport can be moved, which means is active for all

connected bulk material beds. This means can be a conveyor belt. However, it is particularly advantageous to provide a bulk material reception container which extends - like the bulk material delivery container - over the entire bed width and which can be moved in the longitudinal direction of the bed. From the point of view of process technology it is particularly advantageous if both the bulk material delivery container and the bulk material reception container arrive at a position above and below the same bulk material bed. If bulk material delivery installations of the bulk material bed concerned are then opened or actuated, the bulk material which has been drawn off falls immediately into the bulk material reception container and fresh bulk material flows from above out of the bulk material delivery container onto the bulk material bed surface. As a result, a guarantee is provided that the full bed height is always maintained.

In all cases in which a shared disposal channel is provided below adjacent bulk material beds, only a single bulk material delivery location is required for the entire gas treatment installation or series of adjacent bulk material beds, so that comparatively few measures are required to prevent gas leaks. For the disposal channel - as for the charging channel - two possibilities of arrangement can again be implemented: in one arrangement, the disposal channel is provided, instead of bulk material delivery funnels, below the closed gas distribution space. In the other case, the disposal channel is arranged at a higher position, namely within the gas distribution spaces of the adjacent bulk material containers, which, for this purpose, are connected together to the disposal channel, while omitting lateral partitions. As a result, the installation height is further reduced, and the bulk material reception container can fulfill the function of a throttle or barrier means, by closing the gas inlet opening to the gas distribution space below the bulk material bed, or at least reducing its cross section, below which the bulk material reception container is located at that time, so that, at times of bulk material exchange, only small quantities of gas to be treated, or no gas at all, can flow into the bulk material bed located in the bulk material portion exchange.

The charging positions can also be provided at both ends of the process line, to have as small as possible a negative impact on the stream of gas to be treated. It is conceivable to move, in the charging position, the bulk material delivery container also vertically with respect to another stage for processing, for example, in a cycle over two levels. A particularly great advantage is achieved by a two-step, in particular a dry, fluid treatment process according to Claim 18, in which a treatment in the entrainment stream and a treatment in the moving bed, preferably with different treatment agents, are combined and which also has inventive meaning, independently of the characteristics of Claim 1.

The above-mentioned process steps and construction components, to be used according to the invention, as well as those claimed and those described in the embodiment examples, are not subject to any special exceptional conditions with regard to their process conditions, their size, shape, material selection and technical design, so that the selection criteria in each application field can be applied without restriction.

Further details, characteristics and advantages of the object of the invention can be obtained from the following description of the associated drawing in which - as an example - preferred embodiment variants of the charging device and gas treatment installation are shown. In the drawing

Figure 1a shows a fluid treatment installation in longitudinal section (cross section along the line Ia-Ia according to Figure 2b);

Figure 1b an enlarged representation of the right part of Figure 1a;

Figure 2a the same fluid treatment installation in cross section (cross section along line IIa-IIa according to Figure 1a);

In Figure 1a a duct 1 can be seen, on whose right front end a charging station 2 and a gas inlet connector 3 are located, and on whose left end a gas outlet connector 4 is located, through which the fluid treatment installation 10, located inside the duct 1, can be supplied with the fluid to be treated, or the latter can be removed. The duct 1 can thus connect, in the fluid path, pre-connected or post-connected reactors, for example, the inlet side of a thermal reactor, such as a heat treatment installation, and, on the other hand, a post connected fluid treatment/cleaning step or a waste gas chimney. Depending on the existing space situations, the duct 1 can also present at least one fluid deflection loca-

15 With reference to Figures 4a and 4b as well, it will already be mentioned here that the moving bed reactor modules consist of the following components: a bulk material bed 18, of a particulate bulk material, for example, activated charcoal, a catalyst, calcium hydroxide and/or others. The bulk material bed has a base, which is, for example, square, and which is surrounded by lateral  
20 walls, and it has a bed height, for example, 1.2 m which is adapted to the treatment process. It rests on a so-called flow impingement floor 6, which, preferably, has the design known from European Patent No. 0 257 653 B1, that is which consists at least of first bulk material removal funnels 6A or funnel-shaped bulk material removal channels, which are arranged next to each other.  
25 Their lateral walls present passage openings 6B. Above the openings, roof-shaped distribution elements are located, which project from the funnel wall 6A to the funnel interior, and which allow the passage of the bulk material from the bottom and the entry of the fluid into the bulk material bed toward the top. An additional fluid inlet slit forms at the mouth circumference of the second bulk  
30 material removal funnel 6D, which follows in the downward direction immediately after the outlet opening of the first bulk material removal funnel 6A with

circumferential slit. Bulk material outlet pipes 6E, which follow in the downward direction after the second bulk material removal funnel 6D, and which can be designed so they can be telescoped, for thermal and mechanical reasons, penetrate through a dust cover 6F in the form of a cross section filling floor.

5 This floor 6F, the bulk material removal funnel 6A/6D, as well as the external holding walls, comprise a fluid distribution space 6G below the bulk material bed 18. A lateral feed channel 21B, which extends next to a lateral wall of the fluid distribution space 6G, preferably inside of the duct 1, parallel to its longitudinal axis, leads the fluid to be treated along the entire duct 1. Since all the  
10 fluid distribution spaces 6G are provided with a feed inlet window 6H in the partition leading to the immediately adjacent feed channel 21B, each moving bed reactor module of the duct can be evenly supplied with the fluid to be treated, and, the sufficiently large flow cross sections ensure that the pressure loss in all bulk material beds is practically identical.

15 Below the dust cover 6F, under each bulk material outlet pipe 6E, a cycling, horizontally movable, bulk material delivery device 6I is arranged. In principle, its structure can be as desired, for example, as described in greater detail in EP 0 357 653 B1.

20 Above each bulk material layer 18, a gas collection space 7 is located which has a lateral outflow window 7A for fluid connection with an outflow channel 29B for treated fluid. The latter extends along the duct 1 over its entire length.

25 As can be better seen in Figure 3, a bulk material delivery container 12 is provided, which can be moved along guides 22A by means of a simple carriage 30 inside the duct parallel to the duct axis. In the embodiment example shown, the bulk material delivery container 12 presents the same cross section as each moving bed reactor module 5. To allow the movement of each bulk material  
30 delivery container 12 between the charging station 2 and all the bulk material beds 18 to be supplied by it, all moving bed reactor modules can be connected

to each other by a charging channel 15 parallel to the duct axis. See especially Figures 6a and 6b.

5 The bulk material delivery container 12 is further explained with reference to Figures 3-6a. It consists of a flat trough with a multitude of closable unloading openings 14 in the form of mouth openings of bulk material funnels, distributed over a surface area, with bulk material exit pipes 12A. The bottom of the flat trough, that is of the bulk material delivery container 12, corresponds to the type and arrangement of a bulk material distribution floor which is arranged as  
10 a stationary bulk material distribution device between the bulk material reservoir bin and the bulk material bed located under it, and which is already known from EP 0 357 653 B1. The difference compared to the known state of the art consists in that this bulk material distribution floor presents an enclosing frame with a carriage, and is thus designed as a movable conveyance. Below the  
15 outlet mouths of the bulk material exit pipes 12A, a baffle 12B which extends over the entire cross section is located with a distribution and size of bulk material passage openings 12C corresponding to the arrangement of the bulk material exit pipe 12A. In the perspective view of Figure 6a, a front wall and a part of the baffle of the movable bulk material delivery container 12 have been  
20 omitted for clarity's sake.

A special feature of the bulk material delivery container 12 consists of one, optionally additional, lateral wall which serves as a throttle means 27 (Figure 4a/4b) for closing the outflow window 7A. This plate, which is also set in motion  
25 by the bulk material delivery container 12 prevents, in the area in which the bulk material delivery container 12 is located at the time, the transfer of treated fluid from the gas collection space 7 into the continuous outflow channel 29B. As a result, separate closing or throttle valves for each individual outflow window 7A can be omitted.

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The mechanism of operation of the bulk material delivery container 12 is such

that it is loaded with bulk material in the charging position 23 represented in Figure 1a and then moved in each case over the bulk material bed 18 which requires a bulk material exchange. Except during the bulk material portion exchange, the delivery device, such as the baffle 12B, remains closed.

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The charging process which takes place in the charging station 23 can occur in a varying manner. In the embodiment variant represented in Figure 1a, a reservoir bin 2A for bulk material with a closed bulk material delivery floor 2B is provided. By means of the latter, the movable bulk material delivery container

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12 is filled with fresh bulk material from the reservoir bin 2A.

Alternatively, the charging process can occur in the manner shown in Figure 5. Here the reservoir bin 2A has at least one, in the embodiment example three, bulk material exit slits at the lower end, and reservoir bins and/or bulk material delivery containers can be moved relative to each other in the direction of the duct axis. As a result a bulk material layer can be filled from one end to the other end of the bulk material delivery container (in the direction of movement). In the embodiment example shown, the reservoir bin is designed as a movable charging container 16 and subdivided into partial bunkers 2A', 2A'' and 2A'''.

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Each can be filled with a different bulk material. The delivery slits (charging openings 17) are located at varying depths, so that bulk material layers 18A', 18A'', 18A''' are formed in the movable bulk material delivery container 12.

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The bulk material portion exchange occurs in a manner which in itself is known, namely by shifting the bulk material delivery device 6I of the flow impingement floor 6 (Figure 4a) horizontally, releasing the bulk material pipe mouths, while, above the bulk material bed 18, the bulk material delivery container 12 is stationed with opened bulk material exit pipes 12A. The bulk material, depending on the actuation of the bulk material delivery installation 6I, automatically continues to fall from the top to the bottom so that fresh bulk material automatically follows from above.

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The removal of the delivered bulk material can occur in any manner. It is preferred to use a movable bulk material reception container 20, which can have fundamentally the same construction design as the bulk material delivery container 12. Such an example was used in the figures. A continuous disposal channel 19, formed in the duct 1, allows the bulk material reception container 20 to be moved in a position which extends beyond that of the adjacent moving bed reactor modules. This [container] is emptied in the bulk material delivery position 26 shown in Figure 1a.

10 An additional special feature of the movable bulk material reception container 20 is a lateral wall which is designed as a throttling agent 28 which (as in the bulk material delivery container 12) is moved along, and which closes or throttles the fluid passage through the given flow impingement window 6H of the moving bed reactor module under which the bulk material reception container 20 is located. As a result, special adjustment valves are avoided.

A particularly advantageous, alternative way of using heat for the arrangement of the inlet and outlet channels to and from the moving bed reactor modules along duct 1 is shown in Figure 2a. Here a top outflow channel 29A and bottom feed channel 21A were added to the lateral inlet and outlet channels 21B, 29B, whose cross section, however, can now be smaller. These [top and bottom channels] are in fluid connection over the entire length, so that the principal portion of the inflowing fluid, that is the fluid to be treated, can flow out from under the flow impingement floor and the principal portion of the outflowing fluid, that is the fluid to be treated, can flow out above the bulk material beds. The reactor floor and reactor cover, for example, the duct floor and the duct roof are thus heated and replace the accompanying heating used conventionally so far.

30 The fluid treatment installation according to the invention allows an economic fluid treatment, especially of extremely large fluid quantities, for example, sev-

eral hundred thousands or millions of m<sup>3</sup> of gas per hour.

In a particularly advantageous fluid treatment method (Claim 18) the treatment of fluid takes place on two solid bulk materials, combined in an entrainment stream with post connected moving bed, where the moving bed serves as filter and as post reaction stage for the first finely divided bulk material released into the fluid stream and also as the second treatment step. In known methods for a single step treatment, particularly for the cleaning of fluids, in particular gases, with at least one bulk material in the entrainment stream, it is conventional to distribute the first bulk material in an entrainment stream generated by the fluid, and to allow it to be entrained in the latter into a cloth filter where it is retained, while the fluid flows through the cloth filter. A fluid treatment installation according to the invention, in contrast, works in two steps, where, as filter for the entrainment stream step, a moving bed reactor which presents a bulk material bed as filter surface, is used. The latter can be used not only as post reaction step for the (first) entrainment stream step, it also represents a second treatment step. In the latter step, the fluid flows through a bulk material bed from the bottom to the top, and a second bulk material which forms the bulk material bed moves, in countercurrent to the fluid, through the moving bed reactor from top to bottom. At the bottom end of the bulk material bed, bulk material portions are removed, and at the top end of the bulk material bed they are delivered. On the second bulk material, that is the bulk material of the bulk material bed, and in the inter grain volume between its bulk material particles, the first bulk material or a fraction thereof settles out of the fluid stream. Jointly with the bulk material portions to be delivered, the consumed first and second bulk materials are removed at the bottom end of the bulk material bed. This method can naturally also be used advantageously if the filling of the moving bed reactor occurs via stationary storage bunkers and not via the movable bulk material delivery containers according to the invention.

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This method opens a completely new dimension in entrainment stream tech-

nology, allowing a more complex treatment of gases with finely divided bulk materials in an entrainment stream as well as their separation. Indeed, in both cases, the problem is that a so-called filter cake, which continuously increases, forms on the filter. This gradually increases the pressure drop. In addition, the residence time of the gas to be filtered in the filter cake gradually increases. Because, after a certain time, the pressure drop in the filter cake becomes too large, the filter cake must be removed and then reconstructed. This is a costly procedure and leads to discontinuities in fluid treatment. Both problems are prevented by the bulk material filters according to the invention which is designed as a moving bed reactor, because the treatment particles from the sent in fluid are deposited in the inlet zone of the bulk material bed, that is at a place where the bulk material is continuously or nearly continuously removed from the moving bed reactor. As a result the filtration performance remains relatively constant, so that the above-mentioned discontinuities are largely avoided. Thus, a continuously self cleaning filter is achieved here, whose filter cake thickness remains almost constant, and which practically never needs to be cleaned.

A special advantage of this method consists in that the (second) bulk material particles of the moving bed reactor are used for additional fluid treatment steps. Thus it was possible, for example, to add as first bulk material to a fluid stream to be treated, together with the formation of the fluid stream, activated charcoal, by means of which an adsorptive gas cleaning can be carried out, where the latter takes place in part in the entrainment stream phase and in part when this activated charcoal is collected in the moving bed reactor. In this process, the penetration depth of the particles of the first bulk material in the bulk material bed can be influenced by control of the bulk material portion exchange.

The second bulk material particles can consist, for example, of adsorbents, such as calcium hydroxide, NaOH or another solid particulate material suitable

for treatment of fluid for the chemical treatment of inorganic toxins, such as HCl, SO<sub>2</sub>, etc. As bulk material for the movement bed reactors one can use, among others, a granulate made of brown coal, stone coal, limestone and/or sorbalite, which again can also be present in layers in the bulk material bed, which is allowed by the bulk material transport conveyance (bulk material delivery container).

In addition, it is understood that the bulk materials which are delivered from the moving bed reactor modules, can also be delivered separately by bulk material type and be reused, if their fluid treatment capacity has not been completely consumed.

#### Embodiment Example 1

A gas is to be cleaned of gaseous toxic components, which, at least in part, do not lend themselves particularly well for adsorptive binding, for example, HCl, whose separation is to be improved, in comparison to other toxins present in the waste gas, such as heavy hydrocarbons. For this purpose a compound, for example, an alkaline compound, in particulate form (first bulk material) is added to the waste gas with the formation of the entrainment stream cloud. As a result of the addition of, for example, calcium hydroxide (Ca(OH)<sub>2</sub>) as alkaline compound, calcium chloride (CaCl<sub>2</sub>) is produced by a chemical reaction with the HCl. The Ca(OH)<sub>2</sub>, whose particle sizes are, for example, in the µm range, deposits on the surface of the granulate particles (second bulk material) in the bulk material of a countercurrent moving bed reactor of the type represented in the figure. Since this deposit is concentrated on the area of the flow impingement floor of the countercurrent moving bed reactor, the, optionally chemically modified, particles of the first bulk material are delivered together with the granulate particles of the bulk material bed in layers, from the countercurrent bed reactor.

The metered addition of the first bulk material with the formation of the entrainment stream cloud generated by the waste gas to be treated is usually carried out with fixed cycle operation but it can also be carried out continuously. By the fixed-cycle metered addition, a particularly high chemical conversion rate, for example, of the  $\text{Ca}(\text{OH})_2$  is achieved. As a result, the operating costs are reduced.

The waste gas which is to be cleaned, and which generates the entrainment stream, can originate, for example, from the combustion of biogases or liquid or gaseous chlorine containing residual substances in which no or only very little solid extraneous material in the form of dust is contained or produced. In these cases, the metered addition of the first bulk material can be carried out particularly intensively under formation of the entrainment stream cloud.

If the pressure loss increase in the countercurrent moving bed reactor is used as control parameter for the delivery of the granulate/particle mixture, then it is possible that the full load capacity of granulate for heavy hydrocarbons or other toxins to be cleaned from the waste gas will not be completely consumed (this can naturally also be the case for the particles of the entrainment stream cloud). In such cases, the particles (the first bulk material) can be separated from the granulate (second bulk material) after removal from the countercurrent moving bed reactor and it can be recycled, depending on usability, in circulation in the two-step cleaning process.

#### Embodiment Example 2

In sintering processes one uses cost-effective coke as fuel, among other materials. The coke can be used, before combustion on the sintering belt, as an adsorbent in the countercurrent moving bed reactor to achieve the adsorptive cleaning of toxins from waste gases from the sintering process, for example, dioxins, furans, uncombusted heavy hydrocarbons, mercury and other com-

Since relatively large quantities of coke are combusted in such sintering processes, a relatively large amount of second bulk material is available for the bulk material bed of the countercurrent moving bed reactor, so that the separation of toxins and the pressure loss, as well as the metered addition of finely divided adsorbents in the entrainment stream can be adjusted to each other and optimized. While preferred particle sizes of the coke granulates are in the range of 2-6 mm, the particle sizes of particles for the entrainment stream are clearly smaller. Therefore, it is also conventional to first sieve the raw coke, and to use a sieve cross section of more than 2 mm for the countercurrent moving bed reactor and the fine particle portion or parts of the fine particle portion for the cleaning in the entrainment stream.

**Reference List**

	1	Duct
	2	Charging station
5	2A	Reservoir bin
	2A'	Reservoir bin
	2A''	Reservoir bin
	2A'''	Reservoir bin
	2B	Delivery floor
10	3	Gas inlet connector
	4	Gas outlet connector
	5	Moving bed reactor modules
	5A	Partitions
	6	Feed inlet floor
15	6A	First bulk material removal funnel
	6B	Passage opening
	6C	Distribution elements
	6D	Second bulk material removal funnel
	6E	Bulk material outlet pipes
20	6F	Dust cover
	6G	Fluid distribution space
	6H	Feed inlet window
	6I	Bulk material delivery device
	7	Gas collection room
25	7A	Outflow window
	10	Fluid treatment installation
	11A	Outflow channel
	11B	Outflow channel
	12	Bulk material delivery container
30	12A	Bulk material exit pipe
	12B	Baffle
	12C	Bulk material passage openings
	13	Loading opening
	14	Unloading opening
35	15	Charging channel





Claims

1. Method for treating, in particular cleaning, fluids, in particular gases, on at least one bulk material,

5 in which the fluid substantially flows from the bottom to the top through a bulk material bed and the bulk material moves through the bulk material bed substantially from top to bottom countercurrent to the fluid, and in which, at the bottom end of the bulk material bed, bulk material portions are removed and, at the top end of the bulk material bed, bulk material portions are delivered on the bulk material bed,

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where several bulk material beds are operated in parallel and, in particular, the bulk material portion exchange in the bulk material beds occurs substantially successively,

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in which the delivery of bulk material portions is **characterized in** that

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a) for the bulk material portion exchange for the delivery of bulk material portions onto the bulk material bed, a movable bulk material delivery container is used with a bulk material distribution arrangement for the even distribution in layers of the bulk material over the given bulk material bed with at least one loading opening and at least one closable unloading opening,

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b) the movable bulk material delivery container is loaded in at least one charging position with bulk material,

c) the bulk material delivery container is moved over a first bulk material bed and its unloading opening is released, where the bulk material is delivered as long as required for the bulk material

portion exchange, that is until the bulk material bed located under it again has reached its desired height of bulk material, or until the bulk material portion removal is completed,

5           d)     the bulk material delivery container is moved along to another bulk material bed, where the unloading opening, of which there is at least one, is maintained closed if required,

10           e)     the steps of bulk material portion delivery and the subsequent continued movement is repeated for additional beds, and

            f)     after completion of the bulk material portion exchange, in particular for several beds, the bulk material delivery container is again moved into its charging position.

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2.     Method according to Claim 1, characterized in that a movable bulk material reception container, such as a trough or a conveyor belt, is used and, in succession, moved under different bulk material beds for the bulk material portion reception and, finally, into a bulk material delivery position.

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3.     Method according to Claim 2, characterized in that the bulk material delivery container and the bulk material reception container are respectively moved over and under the same bulk material bed, and the bulk material portion exchange quantity is determined by the bulk material portion which has been removed from the bed.

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4.     Method according to one of Claims 1-3, characterized in that the fluid stream to be treated is interrupted or throttled by the bulk material bed located in the bulk material portion exchange by means of the bulk material delivery container or by means of the bulk material reception con-

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which are arranged next to each other and can be operated in parallel, in which the fluid to be treated should flow substantially from the bottom to the top through a bulk material bed and the bulk material moves substantially from top to bottom through the bulk material bed countercurrent with respect to the fluid, by removing, at the bottom end of the bulk material bed, bulk material portions, and by applying, on the top end of the bulk material bed, bulk material portions to the bulk material bed, in particular according to one of Claims 1-7, characterized in that the bulk material beds are interconnected by a shared horizontal charging channel (15) and at least one bulk material delivery container (12) can be moved through the charging channel (15) between a charging position (23) and several bulk material portion delivery positions (24) above the bulk material beds (18).

11. Fluid treatment installation according to Claim 10, characterized in that the charging channel (15), or an outflow channel running above said charging channel and/or an outflow channel running laterally with respect to the charging channel, forms (form) a shared gas collection space of the bulk material beds (18).

12. Fluid treatment installation according to Claim 10 or 11, characterized in that several bulk material beds (18) are interconnected by a shared horizontal discharge channel (19) and a bulk material reception container (20) is movable through the discharge channel (19) between the bulk material portion exchange positions (bulk material portion reception positions 25) and at least one bulk material delivery position (26) below the bulk material beds (18).

13. Fluid treatment installation according to Claim 12, characterized in that the discharge channel (19) or a feed channel which runs under the discharge channel and/or laterally with respect to the discharge channel,

forms a gas distribution space of the bulk material beds (18).

- 5 14. Fluid treatment installation according to one of Claims 11-13, characterized in that the bulk material delivery container (12) or the bulk material reception container (20), or both, is (are) provided with throttling means (27,28), such as closed lateral walls, which close off or throttle gas entry to the bottom of bulk material bed (18) or gas exit to the exterior of the bulk material bed (18), located under or above the bulk material delivery/reception container (12,20).
- 10 15. Fluid treatment installation according to one of Claims 11-14, characterized in that the bulk material delivery container (12) and/or the bulk material reception container (20) consists of at least a series of funnel elements.
- 15 16. Fluid treatment installation according to one of Claims 11-15, characterized in that, for the bulk material portion removal from the bulk material bed (18) and fluid delivery into the bulk material bed (18), a flow path floor (6) is used, in which
- 20 - at least first bulk material removal funnels (6A), which are arranged next to each other or at least one first funnel-shaped bulk material removal channel is provided,
- 25 - in which, in the lateral walls of each funnel (6A) or each channel, passage openings (6B) for the inflow fluid are arranged, and distributed over the funnel circumference or along the channel, and above each passage opening (6B), a roof-shaped distribution element (6C), which is open toward the bottom for flow impingement fluid, projects on the internal side of the funnel or the internal side of the channel from the lateral wall to the funnel interior
- 30

or channel interior.

17. Fluid installation treatment according to one of Claims 1-16, characterized in that it is designed as a longitudinal transfer channel (duct 1), optionally provided with one or more reversal loops, for the fluid to be treated between the fluid output end of a first reactor and the fluid uptake end of another reactor.
18. Method for treating, in particular cleaning, fluids, in particular gases, by means of at least one first bulk material (treatment agent I), in which the first bulk material is delivered to a fluid stream (entrainment stream), and entrained by the latter up to a filter, where it is retained on a filter surface, while the fluid flows through the filter, where the filter cake formed by the first bulk material on the filter is removed, at least partially, from time to time, in particular according to one of Claims 1-7,

**characterized in that**

- a) the fluid to be treated, which is mixed with the treatment agent I, is led, for post reaction and further treatment through a moving bed reactor which forms a bulk material bed made of a second bulk material (treatment agent II), in which the fluid substantially flows from the bottom to the top through the bulk material bed and the second bulk material substantially moves from top to bottom through the bulk material bed countercurrent with respect to the fluid, from which [bed] bulk material portions are removed from the lower end of the bulk material bed and in which [bed] bulk material portions are added at the top end of the bulk material bed, where, on the second bulk material and/or in the interparticle volume between its bulk material particles, the first bulk material or a fraction thereof deposits out of the fluid stream,

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**Abstract**

The fluid treatment installation, in particular for cleaning gases on a bulk material in countercurrent with respect to the movement of the bulk material, is characterized in that adjacent bulk material beds are interconnected by a shared horizontal charging channel (15) and a bulk material delivery container (12) can be moved through the charging channel (15) between a charging position and several bulk material portion delivery positions (24) above the bulk material beds (18). Several bulk material beds (18) can be interconnected by a shared horizontal discharge channel (19), where a bulk material reception container (20) can be moved through the discharge channel (19) between the bulk material portion exchange positions (bulk material portion reception positions) and at least one bulk material delivery position below the bulk material beds (18).

Figure 6a



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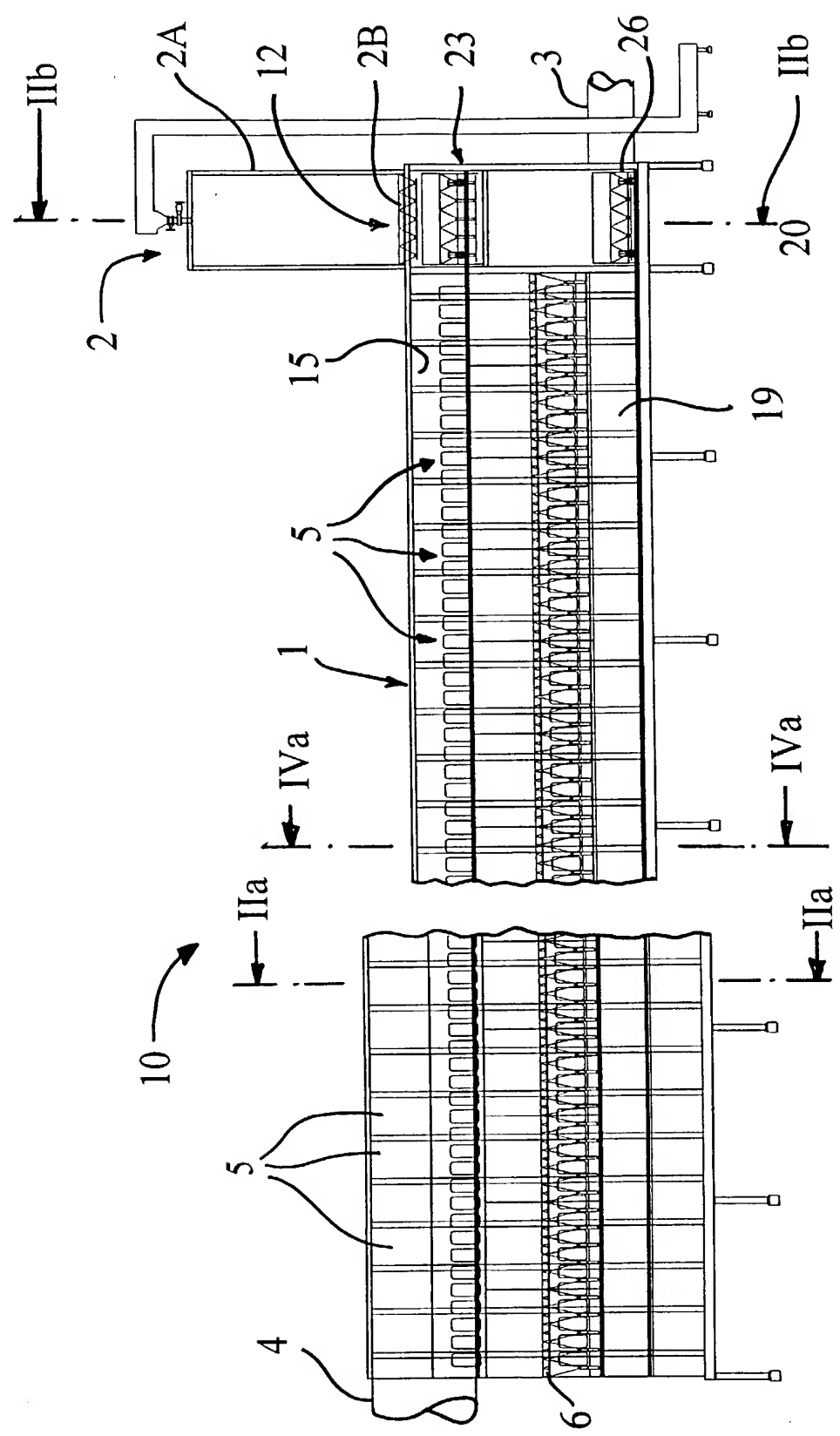


Fig. 1a

217

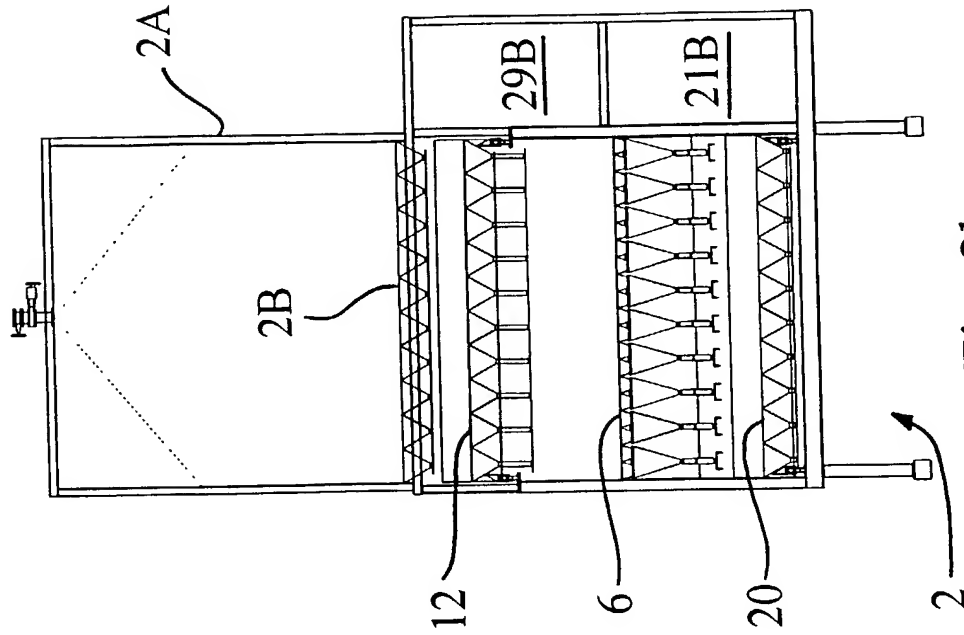


Fig. 2b

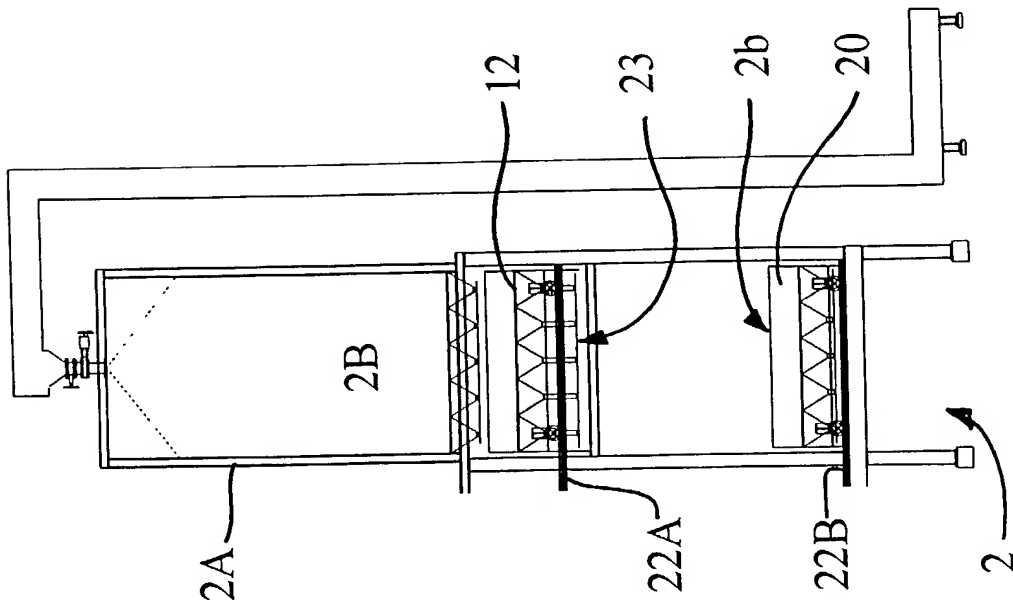


Fig. 1b

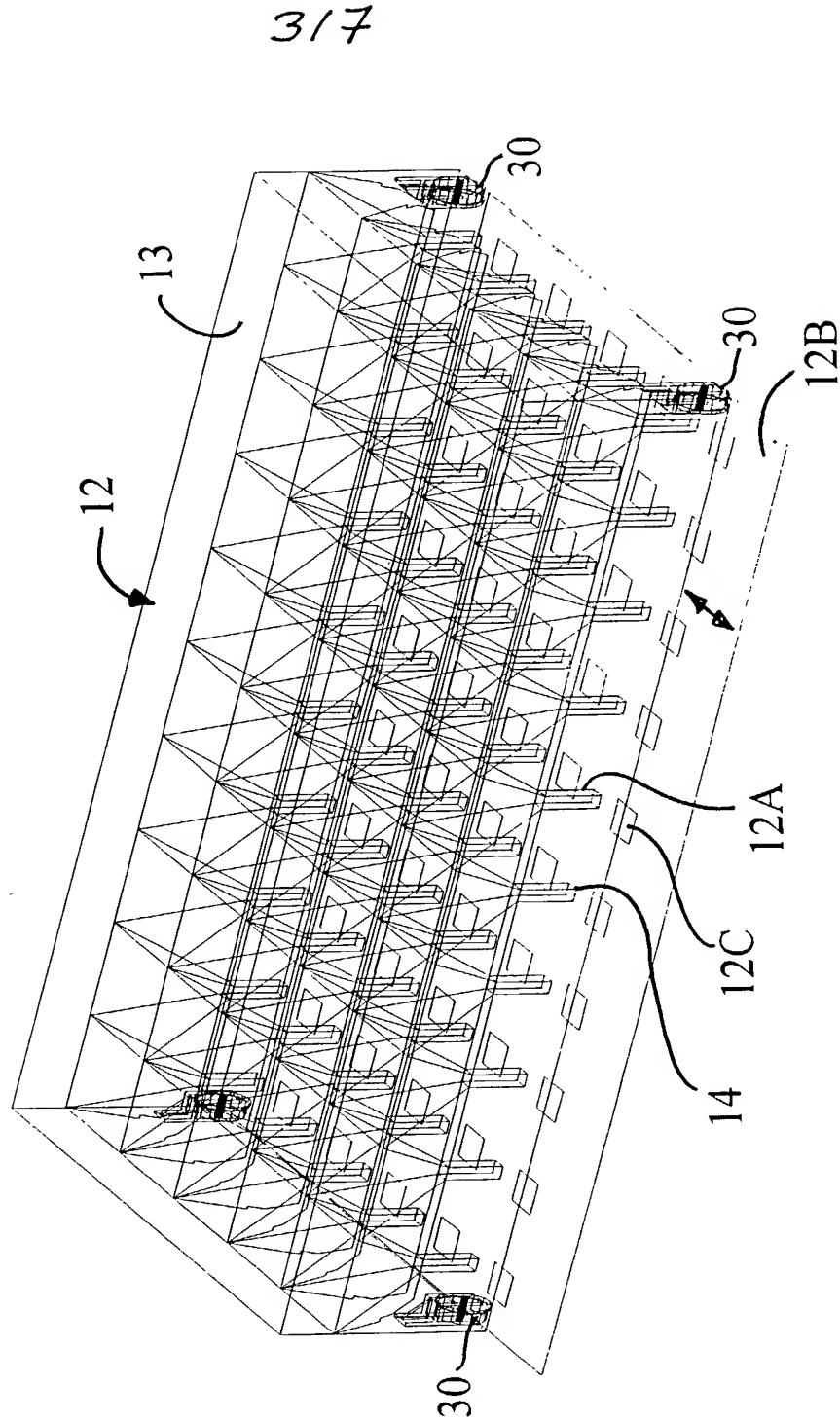


Fig. 3

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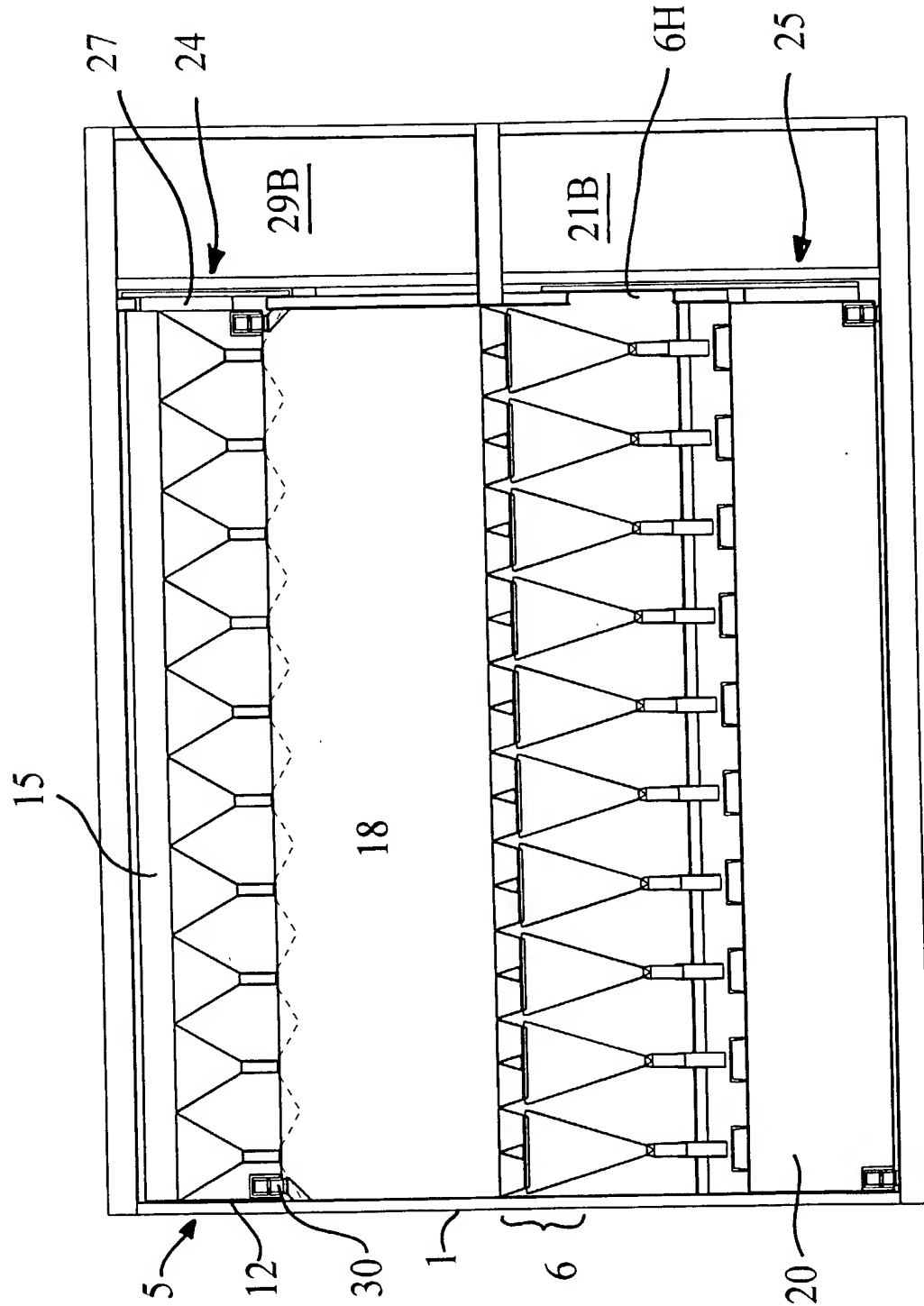


Fig. 4a

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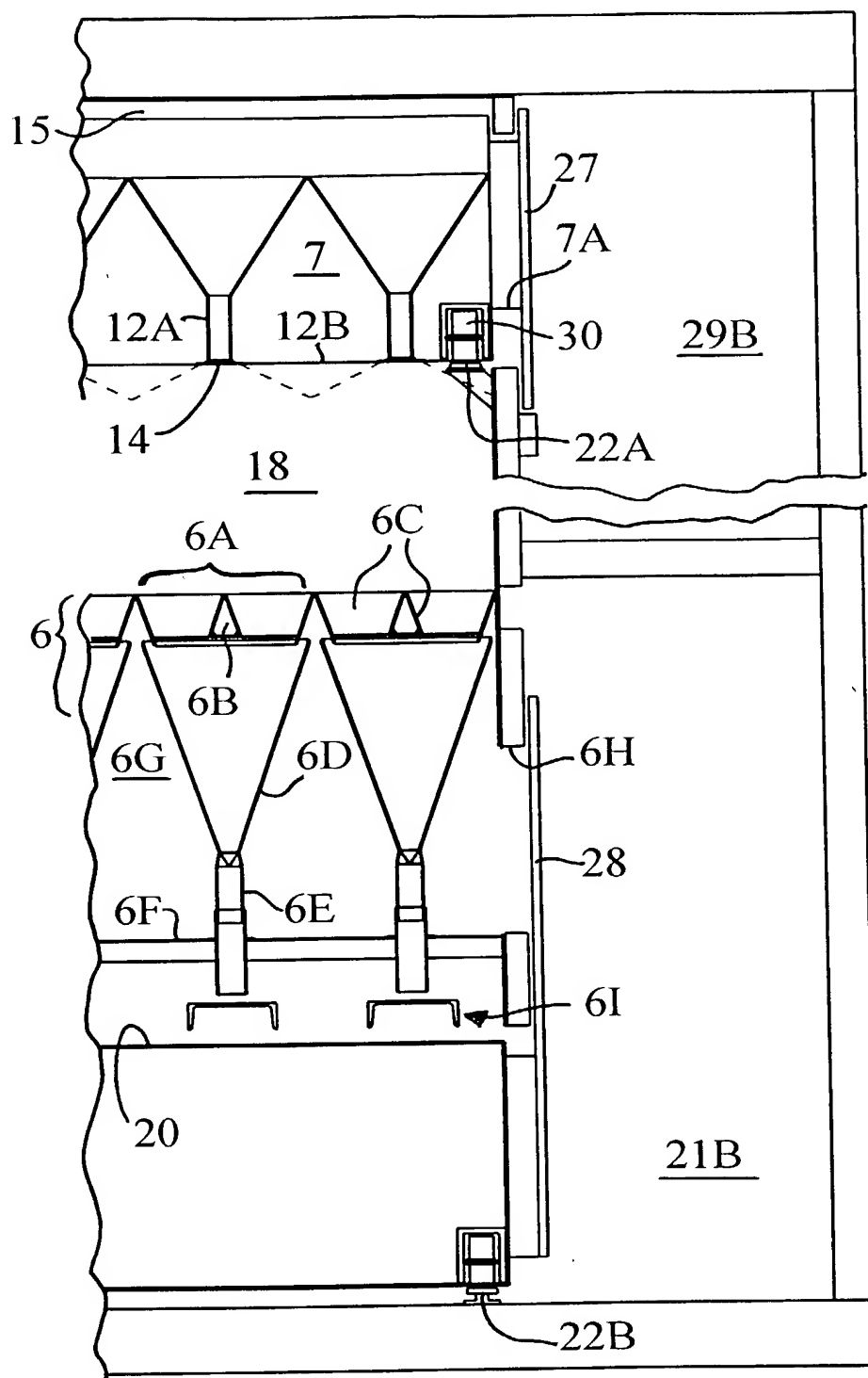


Fig. 4b

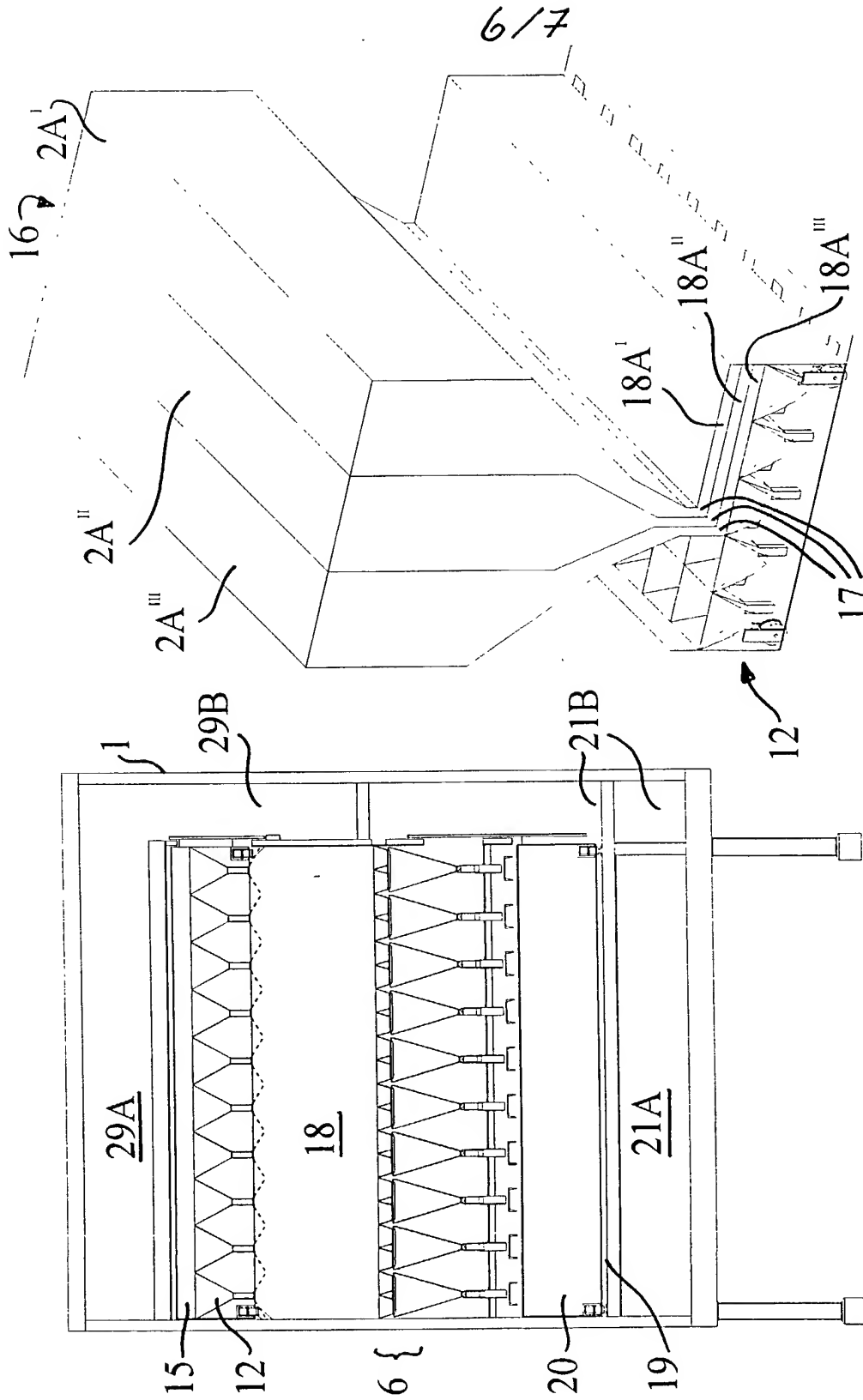


Fig. 5

Fig. 2a

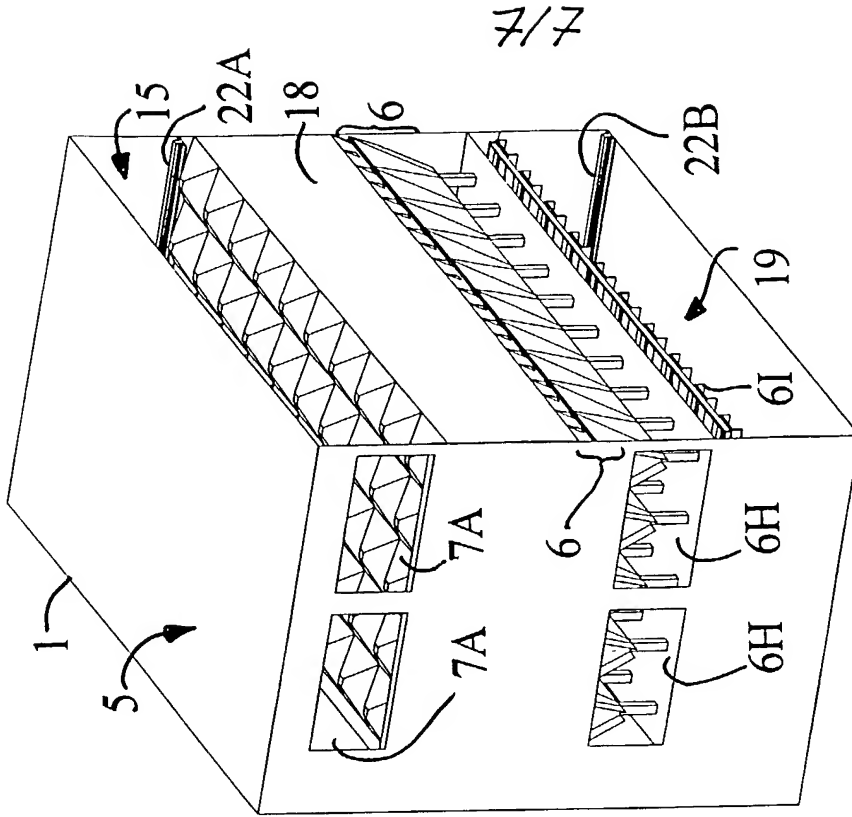


Fig. 6b

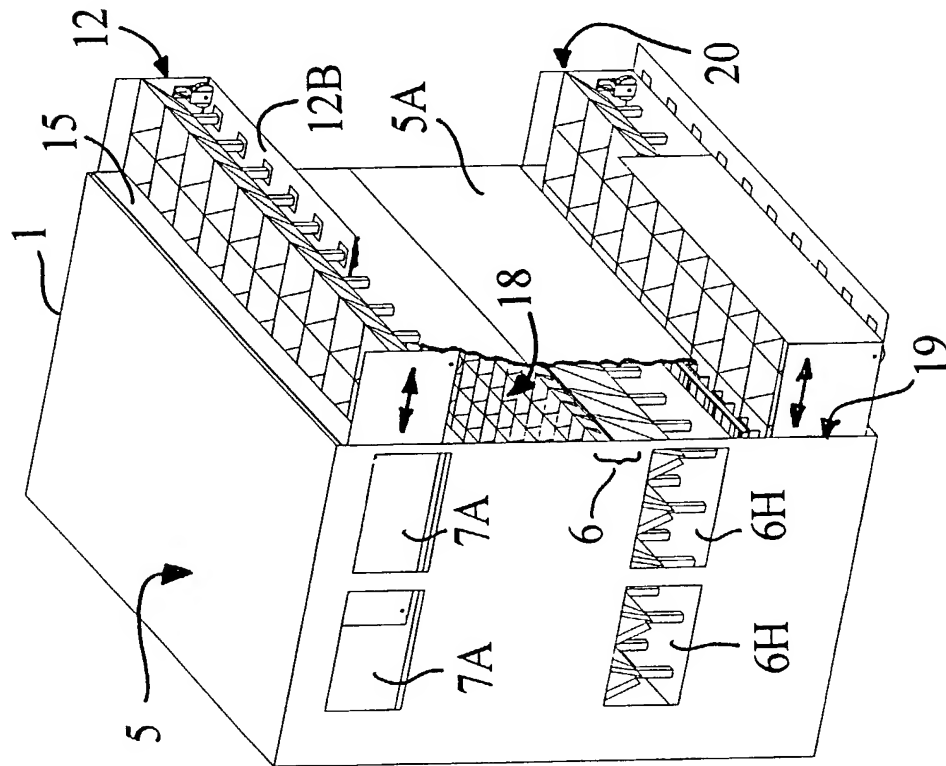


Fig. 6a

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DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION/CONTINUATION-IN-PART PATENT APPLICATION

As a below named inventor, I hereby declare that:  
My residence, post office address and citizenship are as stated beneath my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD, DEVICE AND INSTALLATION FOR TREATING  
FLUIDS ON AT LEAST ONE BULK MATERIAL LAYER**

the specification of which

\_\_\_\_\_ is attached hereto.

X was filed on March 6, 2002 as Application Serial No. 10/070,723  
and was amended on \_\_\_\_\_.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability and/or examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent, inventor's certificate or provisional application listed below, and I have also identified below any foreign application for patent, inventor's certificate or provisional application having a filing date before that of the application on which priority is claimed:

(German) 199 42 335.0 filed September 6, 1999; (German) 199 42 495.0 filed September 6, 1999

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below, and, insofar as the subject matter of each of the claims of this application/continuation-in-part application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112. I acknowledge the duty to disclose information material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<u>PCT/EP00/08710</u>	<u>September 6, 2000</u>	<u>Pending</u>
Application Serial No.	Filing Date	Status
_____	_____	_____
Application Serial No.	Filing Date	Status



And I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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)

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Post Office )  
Address )  
)

Dated this 44 day of May, <sup>2002</sup>~~2001~~

Dated this       day of       , 200\_

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